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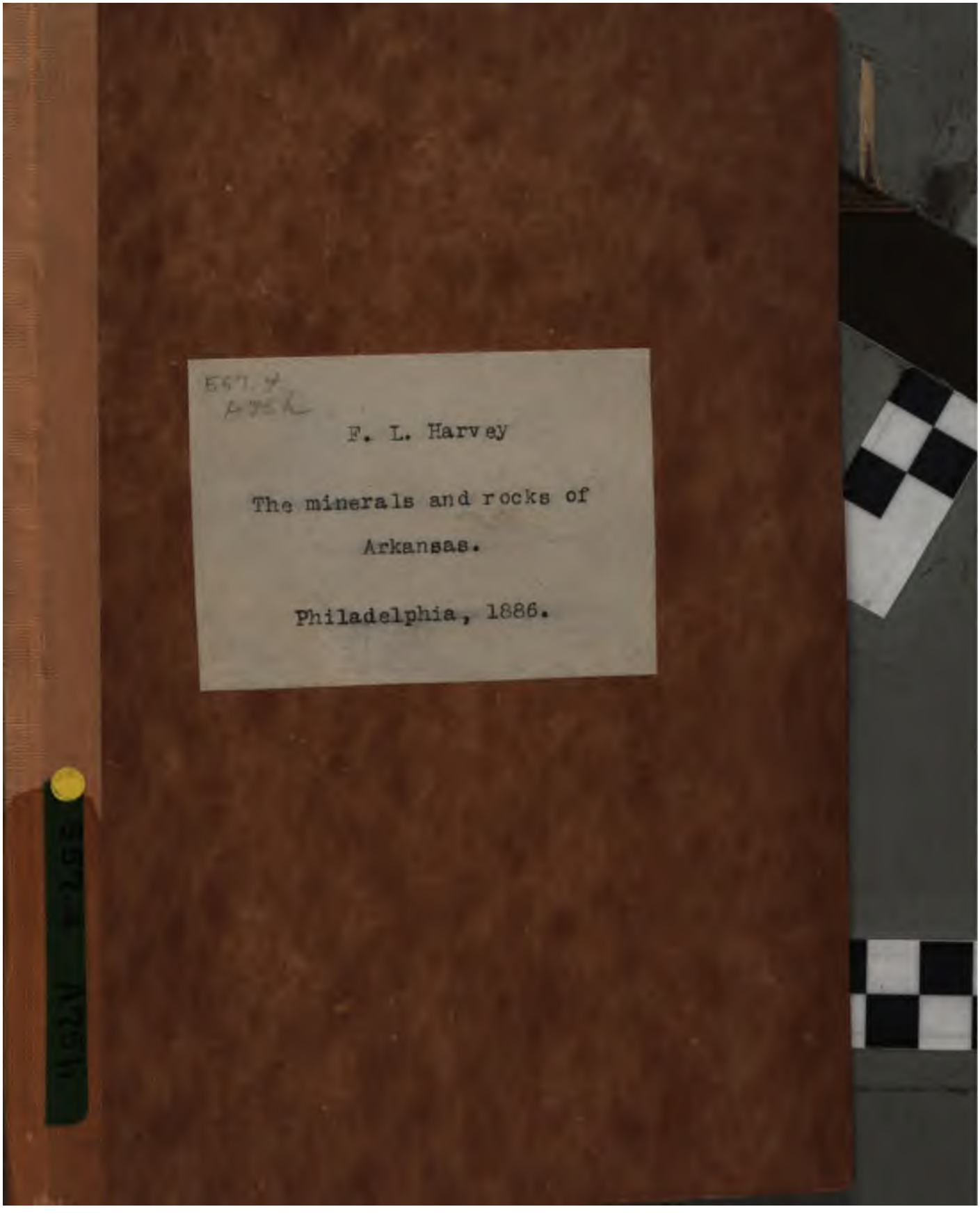
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THE

MINERALS AND ROCKS

OF

ARKANSAS

A Catalogue of the Species, with Localities and Notes

BY

F. L. HARVEY, B. Sc.

LATE PROF. OF BIOLOGY, MINERALOGY AND GEOLOGY IN THE ARKANSAS INDUSTRIAL UNIVERSITY

MEMBER OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA

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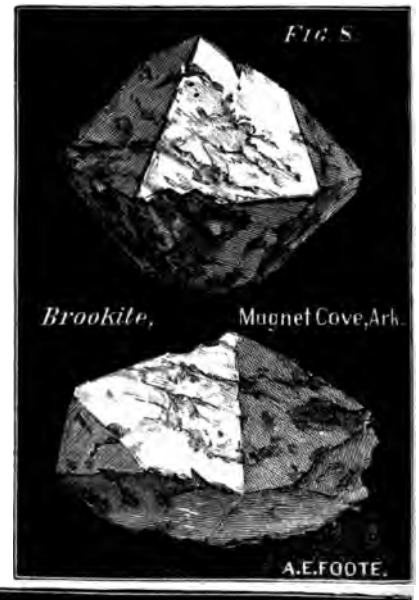

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THE MINERALS AND ROCKS OF ARKANSAS.

BY

F. L. HARVEY, B. Sc.,

OF PHILADELPHIA, PA.

THE topography of Arkansas embraces upland and lowland. The former includes the archean, silurean, subcarboniferous and millstone grit formations; the latter, cretaceous, tertiary, quaternary, and recent. The upland is that portion of the State west of 91° west longitude, and north of 34½° north latitude. The granitic axis of Arkansas begins at Fourche Cove near Little Rock, and runs along the border of the upland to the west boundary of the State.

Igneous outcrops occur in Pulaski, Saline, Hot Springs, Montgomery, Pike and Sevier counties, and there is good reason for believing these igneous rocks are continuous beneath the drainage of the country. Another axis of disturbance shows a granitic out-crop on Spavinaw Creek in the Cherokee country, west of Benton county. The stratified rocks of Arkansas probably rest at no great depth upon an igneous platform.

In northern Arkansas the disturbance shows itself in small faults, gentle folds, and slightly indurated shales; but as you approach the granitic axis, greater faults, strata with high dip, and talcose slates intersected with quartz and calcite veins become common. These disturbances are intimately connected with, and determined the character of the mineral deposits of the State.

The veins along the granitic axis probably were filled by percolating hot alkaline waters, which deposited the metaliferous compounds they contained. The veins and caverns of the silurian and subcarboniferous formations of northern Arkansas were, no doubt, filled in the same way. The water of Arkansas is still quite alkaline, and quartz crystals are at the present time forming about Hot Springs. Having a wide range of geological formations there are a great many mineral species represented in the State.

Almost every variety of soil known to the agriculturist can be found, and for productiveness the soils of Arkansas are justly celebrated. Being composed of uplands and lowland, and having a variety of climate, a wide range of products can be grown. The soils of central and south Arkansas produce the finest cotton in the markets, while the uplands yield a great variety of the most luscious fruits. We know of no place where a greater variety of garden vegetables, small and orchard fruits, grains, grasses, and

other field crops, can be grown with less labor than in Arkansas. Being the best wooded State in the union, timber for all kinds of construction and for fuel can be had at small cost. The mountainous portion of the State is remarkable for the great number and flow of springs. No purer natural waters can be found anywhere. Springs having medicinal properties occur in almost every section of the State. Salt, magnesium, sulphur, alkaline carbonate, alum and chalybeate waters are plentiful, while the hot springs are world wide in their reputation. In a State with such a variety of climate and products even the most fastidious could find a suitable home.

Arkansas cannot boast of her gold mines, and other States will excel her in richness of silver deposits, but in variety of other useful and interesting mineral products she takes a high rank.

The finest kinds of sandstone, limestone, magnesium limestone, marble and granite, suitable for building purposes, are found in the State. Flagging stones and roofing slate are plentiful in some localities, while brick clay of excellent quality is universally distributed. Lumber being plentiful and cheap, one is surprised to see so many brick buildings in the towns of the State. Potter's clay and kaolin are plentiful and of excellent quality.

The brick for that beautiful structure, the Arkansas Industrial University, was made from clay found inside the campus, while the brown sandstone for the basement was quarried a few hundred yards away, and the ornamental grey limestone, used in the façade, procured in Washington and Madison counties. Fine material for hydraulic cement occurs, while the oolitic limestones of the State make the finest lime.

The disintegration of plentiful sandstone gives excellent sand for mortar and some suitable for glass manufacture. The finest honestone in the world is found near Hot Springs. Ochres comparing in quality with those in our markets are widely disseminated.

Extensive deposits of gypsum suitable for making plaster paris occur in southwest Arkansas, but impure gypsiferous and marl deposits adapted for agricultural purposes, are found in many places. The green sand of Arkansas resembles the noted deposits of New Jersey.

The antimony mines of Sevier and Polk counties yield a fine grade of ore in paying quantities.

Beds of iron ore suitable for smelting purposes are found at every geological horizon.

The deposits of manganese ores in Independence county have justly claimed considerable attention.

The coal fields, though not showing so many horizons as some of the States, yet they cover a wide area, and the quality of the coal is good. The brown coals of the south and east part of the State occur in veins of considerable thickness and extent. Zinc, copper and lead ores occur in all the northern counties of the upland, and along the granitic axis from Little Rock to the border of the Indian Territory.

The great timber and mineral belt of northern Arkansas has not claimed the attention it deserves, on account of a want of railroads and the means of marketing the vast undeveloped resources.

It is interesting to know that the Great Eastern Railroad, starting from Fayetteville, is penetrating this region centrally, and will build eastward to the Mississippi river, and westward to the Indian country; joining the coal

fields of the Indian Territory and Kansas with the mineral deposits and forests of northern Arkansas.

The vast quantities of excellent tie and bridge timber, walnut, hickory and pine of one could be exchanged for the coal of the other, to the mutual advantage of both.

To the mineralogist, the State of Arkansas is an interesting region. Arkansas quartz crystals are the finest in the world. The purity and beauty of her titanium minerals are well known, and for variety of mineral products no region is more celebrated than Magnet Cove.

Arkansas only needs capital, railroads and smelting works to take high rank as a mineral-producing State. No extended and systematic search has been made in the State for mineral deposits. All that is known has been discovered, almost accidentally.

The State needs above all things a carefully conducted and detailed geological survey.

A more detailed account of the minerals will be found in proper place in the body of the work.

In writing this pamphlet, to the experience gained by ten years' residence in the State, has been added all available means of information without credit. Much more interesting matter could have been added, but limited space has required many omissions, and it has been no small task to decide what to reject. A few simple tests have been added to aid those who might make use of the pamphlet to determine minerals. We have given what seemed to be the most practical and interesting, and at the same time speak of *all* the mineral species known to the State. Some few doubtful species have been noticed in order to stimulate research. And no doubt more minute investigation will be rewarded by many additions to the list.

In presenting the subject, the plan of Dana's Manual of Mineralogy has been followed, which groups the mineral species under the head of the Basic elements most prominent in their composition, excepting silica and silicates, which are grouped together.

The numbers placed before the species are those of Dana's System of Mineralogy. In speaking of the composition the numbers given are parts of one hundred unless otherwise stated.

The electros used to illustrate this pamphlet were kindly loaned by Prof. A. E. Foote, of Philadelphia, Pa.

The author takes great pleasure in dedicating his work to the State of Arkansas, wishing to make a slight return for the great kindness shown him while a citizen of the State, and with the hope that it may benefit the common wealth of Arkansas by calling the attention of capitalists to her vast undeveloped mineral resources.

CATALOGUE OF SPECIES WITH ANNOTATIONS.

I. ACIDIC DIVISION.

SULPHUR GROUP.

22. Sulphur.

Occurs native in small quantities about sulphur springs, as a yellowish coating, resulting from the decomposition of hydrogen sulphide. Also in shales and coal veins from the weathering of the iron pyrites they contain. It may also be looked for in the gypsum deposits of southwest Arkansas. Can be told by giving a blue flame and sulphurous odor when burned. Though sparingly found *free* in Arkansas, it occurs in many ores as sulphides, and also as sulphates, considered under the proper head.

625. Sulphuric Acid.

The oil of vitriol of commerce. Occurs in small quantities in the water about sulphur springs. Formed by oxidation and hydration of hydrogen sulphide. It soon unites with other substances to form sulphates.

ARSENIC GROUP.

Arsenic minerals are scarce in Arkansas. Found in small quantities associated with antimony, copper, bismuth, iron and silver in Sevier county. Also at Kellogg's Mine in *Tennantite* and *Tetrahedrite*. At the antimony mines it occurs probably as arsenical pyrite, or yellow arsenic sulphide, but not disassociated.

29. Stibnite. GRAY ANTIMONY. ANTIMONY SULPHIDE.

Occurs in Arkansas as divergent, columnar, and fibrous crystals; also massive. Color lead-gray. Fresh broken specimens show a metallic lustre. Tarnishes easily, and is brittle. Melts readily in the flame of a candle. Gives off white fumes and a sulphurous odor before the blow pipe.

When pure, contains 71.8 antimony, 28.2 sulphur. Found in the northern part of Sevier county, where it is associated with silver, gold, cadmium, arsenic, bismuth, cobalt, copper, zinc, lead and iron ores; also in Pike county with galena and Jamesonite.

Shafts known as the Bob Wolf Mine, Antimony Bluff Mine, and Stewart Lode, have been sunk, and large deposits of ore are known to exist. The veins are from a few inches to a few feet thick, and have a considerable out crop. The extreme distance between the shafts is over four miles. They have been worked from time to time, and many tons of ore raised.

Several large shipments made to England demonstrated that the mines could be profitably worked if the means of smelting the ore were near at hand.

When railroads open up this region these mines will become of great value. Some of the ore is exceedingly pure and free from lead. Antimony enters into type metal, various alloys, drugs, and pigments, and there is a constant demand for it.

From Stibnite most of the antimony of commerce is obtained.

227. Cervantite. ANTIMONY OCHRE.

Antimony 79.2, oxygen 20.8. Occurs in acicular crystals. Also massive and as a crust, or a powder. Color, Isabella yellow, sulphur yellow, reddish white or white. Occurs in large masses beautifully crystallized at the antimony mines in Sevier county. Results from the weathering of stibnite.

Large quantities were found near the surface at the Antimony Bluff Mine, but deeper it was mostly replaced by stibnite. Specimens of stibnite partially converted into cervantite are plentiful. It contains a higher per cent. of antimony than stibnite and is a valuable ore.

221. Valentinite. ANTIMONOUS OXIDE.

Has never been reported from Arkansas to our knowledge, but as it occurs with other antimony ores, as the result of their alteration it may yet be found. The same may be said of *senarmontite;* also of *stibiconite* and *volgerite*, hydrated antimony ochres.

30. Bismuthinite. BISMUTH, SULPHIDE.

Composed of bismuth 81.25, sulphur 18.75. Occurs in acicular crystals of a lead gray color, associated with the antimony ores of southwest Arkansas. Though in too small quantities for an ore, as an impurity it would not lessen the commercial value of the antimony. Bismuth enters into a number of useful alloys with antimony. The best type metal contains some bismuth. Scarce.

CARBON GROUP.

25. Graphite. PLUMBAGO. BLACK LEAD.

Contains from 95 to 99 per cent. of carbon. Color iron black to steel gray. Soils paper and feels greasy. Insoluble in acids, and infusible before the blowpipe.

It is a form of carbon resulting from changes in organic matter, due to igneous agencies.

Found in various kinds of crystalline rocks. Occurs in Arkansas along the granitic axis. In Magnet Cove, associated with oxide of iron. In Saline, Polk and Montgomery counties in plumbaginous shales. Arkansas graphite is quite impure.

When pure it is used to lubricate machinery, and for the manufacture of stove polish, crucibles and lead pencils.

Carbonic Acid. CARBON DIOXIDE.

Composed of carbon 27.65, oxygen 72.35. Occurs in the air and in the water of the land and sea. Results from the decomposition of vegetable and animal matter. Given out during respiration of animals. An important plant food. It is the choke damp of mines and old wells. Gives the pungent taste to some mineral waters, and to soda water.

Dissolved in subterranean waters it takes up many substances, and is the

great agent in the formation of caves, stalactites, chalybeate-springs, and deposits of calcareous tufa, and bog ores.

It is found liquid in microscopic cavities in quartz and other minerals.

Combines with many elements to form carbonates, which are of great economic importance, and considered in proper place.

II. BASIC DIVISION.

GOLD.

1. Native Gold.

Distinguished by its golden yellow color; by being scratched readily with a knife and flattened under a hammer. Copper and iron pyrites resemble it in color, and are sometimes mistaken for gold, but they are both brittle. The former gives a greenish powder when scratched, the latter is so hard it turns the edge of a knife.

Along the granitic axis in Arkansas the talcose slates are intersected by a net-work of quartz veins, which appear to be auriferous, but so far have not yielded gold in appreciable quantities.

We are not aware of it, if the quartz and iron pyrites of Arkansas have been examined for invisible gold.

In 1851 Mr. Snell, a mineralogist from New Orleans, claims to have found in Arkansas, in the crevice of a rock, a piece of rich gold-bearing quartz, which weighed an ounce.

During the same year the following statements, which we take from the "American Journal of Science and Arts," appeared in the "N. O. Bee." "Yesterday we had the pleasure of examining three specimens of Arkansas gold, found in the bed of White river above Batesville in a range of rocky country similar in features to the region where Mr. Snell found his specimen. The specimens were dirty quartz, penetrated by the precious metal. We presume that in the three pieces there could hardly have been less than five or six ounces of pure gold. These products of the mineral wealth of Arkansas were sent to Mr. Snell to be assayed." No gold has since been found in this region, nor is the outlook promising. These statements should be accepted with allowance.

Gold has been reported from Saline and Montgomery counties, also a trace was found by Prof. Waite in Arkansas stibnite from Sevier county. Portions of the uplands of Arkansas resemble the gold-bearing regions of Georgia and North Carolina.

SILVER.

40. Argentite.

When pure contains sulphur 12.9, silver 87.1. Lustre, metallic. Color, blackish lead gray.

Resembles some ores of copper and lead. Heavier than the former, and distinguished from the latter by yielding a silver globule on charcoal by heat alone.

Has not been found isolated in Arkansas, but is intimately associated with the copper, lead, zinc and antimony ores of the State. The galena of Arkansas is argentiferous, yielding from a fraction of an ounce to several hundred ounces to the ton.

The galena of northern Arkansas contains so little silver that it could not be profitably worked for that alone, but with lead would be profitable. The per cent. of silver increases in the galena as you approach the granitic axis, and along this the richest silver ores of the State are found. Picked specimens from Kellogg's Mine, Pulaski county, yielded over three hundred ounces to the ton,—specimens from Bellah Mine in Sevier county, over one hundred ounces. The richest from northern Arkansas, nearly forty ounces. Rich ores are also found at the Silver City mines in Montgomery county. The galena of central Arkansas is associated with a quartz and calcite gangue, in veins penetrating shales at the base of the millstone grit. If these veins were followed to the cavernous subcarboniferous limestones which lie below, heavier and richer deposits would probably be found. There is no good reason why the Kellogg and Bellah mines could not be profitably worked for silver alone.

Galena containing only a few ounces of silver to the ton is profitably worked in Europe.

A want of capital and facilities for reducing ores, prevents the working of these mines at present.

No native silver has been reported from the State.

The silver associated with the antimony ores of Arkansas may occur partly as *stephanite*, a double sulphide of silver and antimony.

The galena of northern Arkansas, like that of Missouri and many places, is found in the cavernous limestones of silurian and subcarboniferous ages.

140. Cerargyrite.—HORN SILVER. SILVER CHLORIDE.

Composed of silver 75.3, and chlorine 24.7.

Color, gray, green or blue. Fuses in the flame of a candle, emitting acrid fumes. A piece of iron rubbed with it is coated with silver.

Found in the Mount Ida mining district, Montgomery county, associated with copper pyrites, tetrahedrite and argentiferous galena. We have seen specimens from the Montezuma mine.

COPPER.

12. Native Copper.

There is a specimen in the University cabinet, handed the writer by Dr. J. F. Simonds, and said to have been found by one of his children on Mount Washington, southeast of Fayetteville. The specimen is a red sandstone through which runs a small vein of native copper in a calcite gangue. The sandstone resembles that of the locality. A careful search gave no farther evidence of the metal.

78. Chalcopyrite. COPPER PYRITES. COPPER AND IRON SULPHIDE.

Composed of sulphur 34.9, copper 34.6, iron 30.5. Color, brass yellow, often tarnished deep yellow, and also iridescent.

Resembles gold and iron pyrites, but crumbles under a knife, while iron pyrites strikes fire with a steel. It has a deeper yellow color than pyrites. Dissolves in nitric acid. If ammonia be added to the solution it becomes

deep azure blue. A piece of iron placed in the solution is coated with metallic copper.

The most common copper ore. Varies greatly in richness. The more brittle the better. Found in Arkansas in veins penetrating the metamorphic slates, also in cavernous limestones of the northern part of the State. Occurs in considerable quantity associated with lead and zinc ores in Carroll, Fulton, Independence, Izard, Lawrence, and Marion counties, also with lignite in Greene county.

The most promising mines are the *true* veins on the north side of the axis of disturbance, showing surface ore in Pulaski, Saline, Montgomery and Sevier counties.

The prospects for copper ore are good. We learn that well defined masses have recently been found along the line of the Great Eastern Railroad in Marion and Boone counties.

In Dr. Owen's Second Report, p. 145, copper ore is said to occur in Ashley county near Hamburg. This has not been further investigated.

127. Tennantite. GRAY SULPHURET OF COPPER.

A compound of copper, iron, sulphur and arsenic, of a dark lead gray color. Found associated with lead and zinc ores at Kellogg's Mine, also in Montgomery county and northern Arkansas.

Associated with, and hard to distinguish from the next, excepting by the blow-pipe.

125. Tetrahedrite. GRAY COPPER.

A double sulphide of copper and antimony. Part of the copper is usually replaced by iron and zinc; sometimes by silver, or quicksilver. The antimony may be partly replaced by arsenic, or bismuth. Carries considerable silver. Occurs at Kellogg's Mine, and at various mines in Montgomery county, and together with *Tennantite* is called gray copper, but can be distinguished by giving the antimony reaction.

178. Melaconite. BLACK COPPER OXIDE.

This, an abundant ore in some of the Mississippi Valley mines, has not been reported from Arkansas, but will no doubt be found with the copper ores of the State. May be looked for as a black powder, and in dull black masses and botryoidal concretions, giving copper reactions.

669. Chalcanthite. BLUE VITRIOL.

Sulphate of copper. Occurs with the sulphides of copper as the result of their decomposition, and in the water flowing from copper mines. In some copper regions the metal is obtained by placing clean iron in the water. Water containing blue vitriol would be injurious to health. Used largely in medicine and the arts, and called *blue stone*.

751. Malachite. GREEN COPPER CARBONATE.

Composed of copper, carbonic acid and water. When pure contains 71.9 per cent. of copper oxide. Color, light green. Occurs in Arkansas as an incrustation, and in earthy masses associated with other copper ores. This mineral is highly esteemed for jewelry, mantel-pieces, vases, and other ornamental objects. It takes a high polish. Not in sufficient purity or

quantity in Arkansas for these purposes. A good copper ore. Reported from Sevier county and North Arkansas.

752. Azurite. BLUE COPPER CARBONATE.

Composed of copper, carbonic acid and water. When pure contains 69.2 of copper oxide. Color, deep blue, azure blue or Berlin blue.

Associated in Arkansas with green carbonate of copper and the other copper ores. A valuable ore. Sometimes used as a pigment, but fades to green. Scarce in Arkansas. Reported from Sevier county and North Arkansas.

346. Chrysocolla. HYDROUS COPPER SILICATE.

Composed of copper, silica and water. Occurs as incrustations and massive. Never crystallizes. Color, bright green and bluish green. Has a smooth, shining surface. Distinguished from green carbonate by brighter color. The green carbonate effervesces with nitric acid, and is soluble in it.

Contains 30 per cent. of copper when pure, and is a good ore. Found with other copper ores in Arkansas. *Scarce.*

LEAD.

The ores of lead are heavy and soft. They fuse readily before the blow pipe on charcoal and give a globule of lead. The charcoal is covered with a yellow coating, and yellow fumes are generally given off.

44. Galenite. GALENA. LEAD SULPHIDE.

When pure contains 86.6 lead and 13.4 sulphur.

Color, lead gray. Crystallizes in cubes or modifications of the cube. Cleaves readily into cubical blocks. which have shining facets.

This is the prominent lead ore of all countries, and the only workable one in Arkansas. Has been reported from all the northern counties of the State. Also, from Pulaski, Saline, Montgomery, Polk, Pike, Ashley and Sevier counties. Large quantities are known to exist. North Arkansas is a continuation of the noted lead regions of southwest and southeast Missouri, which have yielded such rich deposits at Granby, Short Creek, Oronogo, &c. The galena of Arkansas is argentiferous, bearing from a fraction of an ounce to several hundred ounces to the ton. With the erection of smelting works and the construction of railroads, these deposits are destined to become a great source of wealth to the State. Quartz and calcite are the gangues of galena in Arkansas. It often occurs in magnificent clusters of cubes. Associated with copper, zinc and other lead ores in Northern Arkansas, and also with antimony, in Sevier county. Found in the silurian and sub-carboniferous limestones; also, in the shales at the base of the millstone grit.

112. Jamesonite. GRAY ANTIMONY. NEEDLE ANTIMONY.

This is a double sulphide of lead and antimony. Variable in composition. Color, lead gray to a bluish black. Occurs massive, fibrous, acicular, capillary and in cobweb-like crystals. Beautiful specimens occur in Sevier county, at the antimony mines, with spiral-like capillary crystals. A specimen examined by Prof. Waite gave lead, antimony, iron, copper, bismuth,

cadmium, silver and a trace of gold. Other specimens yielded zinc. Found also in Pike county.

106. Zinkenite. SULPHIDE OF LEAD AND ANTIMONY.

Associated with Jamesonite in Sevier county. Differs from it in containing more lead. Scarce.

633. Anglesite. LEAD SULPHATE.

Affords 73 per cent. of oxide of lead. Color, white, gray or green. Fuses in flame of candle.

Associated with galena in Northern Arkansas, and results from its decomposition. Scarce.

586. Bindheimite. HYDROUS LEAD ANTIMONATE.

Reported from the Antimony mines in Sevier county, where, according to Prof. Waite, it is found as a lemon-yellow powder, easily crumbling between the fingers. It yielded oxides of lead, antimony, iron, water and silica. Rare.

729. Cerussite. WHITE LEAD ORE. LEAD CARBONATE.

Color, white, grayish, light or dark. Contains 83.5 per cent. of lead oxide. Effervesces with nitric acid.

Occurs sparingly with galena in north Arkansas. A rich ore. Formerly not worked, but now smelted. Artificially prepared it is the *White Lead* of commerce used as a paint, and for making putty.

ZINC.

56. Sphalerite. BLENDE. ZINC SULPHIDE.

Composed of sulphur 33. zinc 67. Color, wax yellow, brownish yellow to black. Sometimes green, red and white. The black, reddish brown and wax yellow are most common in Arkansas. Cystallizes in modifications of the cube, also occurs massive. Nearly infusible.

Dissolves in nitric acid, emitting sulphuretted hydrogen. Has a waxy lustre and cleaves easily. Brittle.

A common ore in Arkansas found with galena, stibnite and other zinc ores. This is the "*Black Jack*" of the miners. A useful ore, but rather hard to reduce.

723. Smithsonite. CARBONATE OF ZINC.

Composed of carbon dioxide 35.2, zinc oxide 64.8.

Color, impure white, green, brown, pale yellow, flesh color and pale red. Effervesces with nitric acid. The crystals on drusy surfaces usually terminate in three-sided pyramids.

Occurs in large deposits in veins and cavities in the magnesium limestones of north Arkansas, especially in Lawrence, Marion, Boone and Carroll counties. Usually imbedded in a stiff red clay in dolomite. The clay and dolomite both contain some zinc. The ore is often cellular. The most common ore of Arkansas.

749. Hydrozincite. (MARIONITE.)

A Hydrous carbonate of zinc, of a white color. Contains zinc oxide, carbonic acid, and water.

A common ore in north Arkansas. Called Marionite after Marion county, where Dr. Owen first discovered specimens. Like the other zinc ores of Arkansas it probably results from the decomposition of sphalerite.

Calamine. HYDROUS ZINC SILICATE.

Composed of zinc oxide 67.5, silica 25.0, water 7.5.

Color, white, blue, green or brown. Crystals, rhombic prisms, also massive, and incrusting, mammillated or stalactitic. Associated with smithsonite and hydrozincite, and with them called "dry bone." Told from smithsonite by not effervescing with acids.

CADMIUM.

69. Greenokite. SULPHIDE OF CADMIUM.

This is the only ore of cadmium known. Occurs in small quantities associated with zinc ores in north Arkansas, and the antimony ores of Sevier county. No isolated specimens have been reported. They may be looked for as light yellow crystals and coatings.

TITANIUM.

This rare element is widely disseminated in the Ozark mountains of Arkansas in the form of titaniferous iron ore and other compounds, but occurs in Magnet Cove, Hot Springs county, in the following finely crystallized species.

193. Rutile var. Nigrine. OXIDE OF TITANIUM.

Crystallizes in prisms with four, eight or more sides. The crystals bend so as to form rosettes. Black with a high lustre. Quite plentiful in Magnet Cove, where geniculated crystals of great beauty, single and in groups, are found. The illustration is a fine rosette from this locality. The purest titanic acid and the finest rosettes in the world occur in Arkansas. Specimens have not been found in place in the gangue, but are picked up in the fields after rains.

Occurs also as a paramorph after Arkansite, that is, Arkansite by alteration is changed into numerous small rutile crystals, while the form of the Arkansite crystal is retained. See Fig. 7, frontispiece. Rutile is used to paint on porcelain, and to give the natural color and enamel to artificial teeth.

198. Brookite. TITANIC OXIDE.

Has the same composition as rutile, but crystallizes in a different system. The crystals by twinning and truncation take on various forms, a few of which are figured. Occurs at Magnet Cove in quartz and sandstone gangues, and also loose in the soil. The black, opaque, submetallic crystals found in Arkansas are called *Arkansite*. There is a specimen in the Arkansas University collection of a yellow color. The oxide

of Titanium is interesting as crystallizing in several systems, that is, showing polymorphism.

Arkansite has an exceedingly interesting history. It was discovered by Dr. W. B. Powell, of Memphis, in about 1846, who gave specimens to Rev. E. R. Beadle, a missionary of New Orleans. Rev. Beadle sent specimens to Professor Charles U. Shepard, who gave the original description and name.

By a chemical examination Prof. S. pronounced it Titanic acid, Yttria and Thorina (?)

It was re-examined in 1847 by Professor Rose, who regarded the Titanic acid found by Prof. S. an acid of a new metal Niobium. After a more extended analysis, Professor Shepard concluded it was Niobate of Yttria and Thorina. In 1849 it was examined by Professor Whitney, who pronounced it simply *Titanic Acid* with a trace of iron. It is not often that a species has occupied so many and such royal positions.

Hydrotitanite. HYDRATED OXIDE OF TITANIUM.

This species discovered by Dr. Konig is the result of alterations in Perofskite. The form of the Perofskite is retained, but the most of the lime and iron are replaced by water. The surface of perofskite crystals often show weathered spots. The altered crystals when broken are yellowish gray. Common in Magnet Cove.

182. Perofskite. TITANATE OF LIME.

Occurs quite plentiful at Magnet Cove in cubes and modifications of cubes of a shining black color. We give two cuts of the more common modified forms.

COBALT AND NICKEL.

Cobalt has been reported by Professor Waite, from Sevier county, associated with stibnite. Probably as cobalt sulphide. Also occurs with iron ores in Lawrence county. *Nickel* has not been reported from Arkansas, excepting from a meteorite. It may be looked for as *millerite* in the magnesium limestones of the silurian age. It occurs near St. Louis, Missouri, as needle, or hair like crystals, stretching across geodic cavities in magnesium limestone

81. Linnæite. COBALT AND NICKEL SULPHIDE.

Occurs at Mine la Motte, Missouri, and may yet be found in Arkansas.

IRON.

Has been found native in Arkansas only in meteorites.

The compounds of iron are widely disseminated in workable quantities. Beds of considerable extent have been observed in every portion of the State. Capital, and railroad communication with suitable coal-fields, would make the working of these ores possible, and bring much wealth to the State. Ores and coal are often both shipped a considerable distance to smelting works. The following compounds of iron have been observed in Arkansas.

75. Pyrite. IRON PYRITES, IRON BISULPHIDE.

Composed of iron and sulphur. Gives off sulphur when heated on charcoal with a blow pipe, and leaves behind a globule attracted by the magnet. *Nearly all iron* compounds leave a magnetic globule after being heated. Pyrites often contains gold. One of the most common ores.

Called "fool's gold," also "Mundic" by the miners. Not a good ore to work for iron, as the sulphur cannot be easily separated. It however affords the most of the green vitriol and sulphuric acid of commerce, also considerable sulphur and alum. It decomposes readily when damp and in contact with the air.

Rocks containing it should be rejected for architectural purposes, as it is a great agent in their disintegration.

Widely distributed in the shales, coal, and other rocks of Arkansas. Was used in Magnet Cove to obtain sulphur for powder during the Rebellion.

Fine cubical crystals occur with the lead and zinc ores, also in Magnet Cove and elsewhere. Also found as concretions in shale about the coal veins.

90. Marcasite. WHITE PYRITES.

Composition same as above, but crystals trimentric. Often mistaken for silver ore, on account of its light color. Occurs at various localities in the State. Some of the pyrites of Arkansas contains arsenic. When this is the case it is called *Arsenopyrite* or *Mispickel.*

180. Hematite. SPECULAR IRON ORE.

Occurs in Arkansas as a red earthy mineral known as red ochre, also in some places in the massive form *Red Hematite.* There are no bodies of specular and micaceous iron as occur at the Iron Mountains in Missouri. A valuable ore in most of its forms, though rather harder to reduce than limonite and magnetite.

It makes a good polish for metals, gives color to brick, and occurs in the form of red chalk. Is used as a mineral paint and pigment for brick work. It may be looked for at Magnet Cove as *Martite* from the decomposition of magnetite crystals. Occurs in Lawrence county in cavities of brown hematite, as stalactites of a bright red color, also in a very pure form associated with the manganese deposits of Independence county.

181. Menaccanite. TITANIC IRON.

Oxide of iron and titanium. Color, iron black. Occurs in beautiful bright crystals at Magnet Cove, and disseminated widely through the State, giving a dark color to various rocks. We figure a crystal. Takes a high polish. Natural forms ornamental. Deleterious to iron ores.

FIG 17

185 A. Dimagnetite.

Composition the same as magnetite. Occurs in Magnet Cove as pseudomorphs after the titanium minerals, particularly Brookite.

186. Magnetite. MAGNETIC IRON ORE.

Contains 72.4 per cent. of iron. Plentiful in Magnet Cove where a large

mass of it is found. The surface over several acres is covered with pieces of this ore having strong polarity. Loadstone from Magnet Cove has a high reputation, and considerable is shipped. This deposit would afford plenty of fine ore for smelting. It is one of the best ores. Is owned by Dr. Lawrence, of Hot Springs. Fine crystals are common. There being no coal beds near prevents working at present, but railroads sooner or later will make the coal fields of the Indian country available. The ore or the coal could be transported.

206. Limonite. BROWN HEMATITE.

Composed of oxide of iron and water. There are several varieties of this ore in Arkansas.

Var. Brown Hematite occurs in quantity in Lawrence, Randolph, Fulton, and other counties, and may be recognized by its usual brownish yellow exterior, and brownish red color when broken. It gives a clay like odor when breathed upon, and usually adheres to the tongue. Occurs massive, also as stalactites, and as surfaces covered with rounded prominences.

Var. Brown and *yellow ochre*, are earthy varieties of various shades of brown and yellow. Ochres of fine quality occur in many places in Arkansas suitable for mineral paint, polishing material, or dye stuff. Widely disseminated in soils and rocks giving color to them.

These ochres are especially plentiful in the tertiary formations or low country, and sometimes have a beautiful pink color.

Var. Bog iron ore. A loose earthy, brownish black ore. Very common in the low country. Large deposits occur in Pope, Pulaski, Bradley, Hempstead, and other counties, also in more limited deposits in north Arkansas.

The forms of *limonite* are the most common iron ore of the State. This is one of the best ores known, and small furnaces erected in Lawrence county long ago demonstrated that a fine quality of iron can be made from Arkansas ore. The bog iron ore of South Arkansas would be best adapted for cast iron, while the limonite of North Arkansas, being free from sulphur and phosphorus, could make good malleable iron.

664. Melanterite. COPPERAS, GREEN VITRIOL.

Composed of iron and sulphuric acid. Color, greenish or white. Taste, astringent, sweetish, metallic. Common about shale and coal heaps. Results from the oxidation of the pyrites they contain. Found in some quantity in St. Francis county, and other places. Used in the arts for tanning, dying, making ink, and Prussian blue.

721. Siderite. SPATHIC IRON. IRON CARBONATE.

Contains 62.1 per cent. of iron oxide. Color, light gray to brown or brownish red. Turns black on exposure. Effervesces with hot muriatic acid. When crystallized it cleaves readily into rhombic blocks like calcite and dolomite, but is much heavier than either. Occurs crystallized at Kellogg's Mine in Pulaski county. Massive, as seams in shale beds, in Franklin, Washington, and other counties. As clay iron stone concretions and nodules in the shales of the coal measures. Also as earthy clay carbonate. A valuable ore, and employed extensively in the manufacture of iron and steel. Occurs in workable quantities in Arkansas. The *bicarbonate of iron* is found in the waters of Iron or Chalybeate Springs.

MANGANESE.

The metal manganese alone is of no importance in the arts, but it enters into spiegeleisen, a highly crystallized pig iron of great value.

Manganese oxides are used largely to liberate chlorine for bleaching purposes, and their value depends upon the oxygen they contain.

The presence of Baryta and earths lessens the value greatly. The compounds of this metal give a violet color to glass, and the beautiful color to amethystine quartz. Also used in calico printing. The compounds are widely disseminated in the State, but in workable quantities, only in Independence county, where large deposits occur in the cavernous limestones of subcarboniferous age. In quantity and quality the Manganese ores of Arkansas undoubtedly excel those any of the western States, and compare well with foreign ores. These ores are now attracting considerable attention for the manufacture of spiegel iron for steel. The ore is quite free from phosphorus. The ore for steel is imported from Spain. The following compounds have been observed.

199. Pyrolusite. MANGANESE DIOXIDE. BLACK OXIDE OF MANGANESE.

When pure contains over 36 per cent. of oxygen. The best ore for liberating chlorine. Occurs in Independence county as a soft black compound associated with *psilomelane*. Plentiful.

196. Braunite.

An oxide of Manganese containing less oxygen than pyrolusite. A massive ore of a dark steel gray color and submetallic lustre. Reported from Marion county.

217. Psilomelane. HYDRATED OXIDE OF MANGANESE.

Composed of Manganese protoxide, water and baryta or potassa. Variable in composition. Massive; lustre submetallic; color, between steel gray and iron black; fracture hackly, and when broken frequently resembles cast iron; hard and brittle; strikes fire with a steel, and when crumbled gives a reddish powder.

Associated with pyrolusite in Independence county. Probably the most common manganese ore of the State. Does not contain so much oxygen as the black oxide. Suitable for the manufacture of spiegel iron.

218. Wad. BOG MANGANESE ORE.

Consists of manganese dioxide nearly 70 per cent., when most pure. Mixed more or less with red oxide of iron and water. Often contains cobalt and copper. It is formed in low places from the decomposition of manganese minerals. Often deposited in beautiful fern-like delineations in crevices on the faces of rocks, and then called dendritic manganese. Beautiful delineations are common on honestone and flint rocks in Arkansas. Wad is often deposited by springs holding the bicarbonate in solution. Beautiful specimens are found in the tufa ledge, at Hot Springs, probably deposited from surface water, as wad is common in the hills near by.

Wad is often used for an umber paint.

ALUMINUM.

179. Corundum.

Composed of oxygen and aluminum. We have seen specimens of corundum crystals of a bluish gray color and prismatic form, said to have

been collected in Sevier county, or the northern part of Howard. Specimens of emery have been seen from the northeastern part of the State. Well crystallized specimens of this species are called sapphire; also oriental ruby, topaz, emerald or amethyst, in accordance with the color.

671. Alunogen. HYDROUS ALUMINUM SULPHATE.

Composed of oxide of Aluminum, oxide of sulphur and water. Occurs as a white coating in dry weather upon the surface of shale rocks containing pyrites. Has taste of alum. Quite common in Arkansas about coal shales, also in dried up mud holes resting on shale formations.

565 A. Variscite. PEGANITE.

Occurs in the region about Hot Springs as crystalline incrustations upon quartz, or in thin seams through it. It also occurs amorphous disseminated through quartz. Sometimes found in aluminous rocks. The crystals are often in clusters of sheaf form, or in semi-globular masses with a radiated structure. Perfect prismatic crystals large enough to be measured have been found, but they are usually small. Color, a beautiful emerald green with a high lustre. Sometimes bluish green or colorless. Crystals often are dark in the middle and light at both ends.

Sometimes associated with *Wavellite*, but has a much lighter green color. It also resembles beryl.

554. Wavellite.

Composed of phosphorus pentoxide, alumina and water. Sometimes a small quantity of fluorine. Color, in Arkansas usually green, sometimes white.

Occurs in small hemispheres sometimes an inch across, attached to the surface of crevices in the rocks. These balls when broken show a beautiful radiated structure, leaving a stellate circle on the rock.

Occurs usually in a grayish metamorphosed sandstone, but specimens in slate have been seen in Arkansas. Usually reported from Magnet Cove and Montgomery county. It is doubtful whether it occurs in Magnet Cove proper, and it is found in several counties in the region of Hot Springs. We give an electro cut of this beautiful mineral, which is called "*cat's eye*" in Arkansas.

MAGNESIUM.

The compounds of magnesium are widely disseminated as the carbonate, chloride and sulphate in the soil, and in the water of springs and wells. Magnesium salts are essential to vegetable and animal life. Found in considerable quantity in the ash of plants. They give the bitter taste to

sea water, and act as a laxative upon the system. When in considerable quantity they aid in making water hard.

661. Epsomite. EPSOM SALTS. MAGNESIUM SULPHATE.

Found as white fibrous crusts on the walls of caves, or as small glistening crystals in the earth on the floor of caverns. This is the well-known laxative obtained at the shops under the name of "salts."

593. Nitromagnesite.

Occurs in limestone caves as a white efflorescence having a bitter taste. Formed from magnesium salts in the presence of organic matter. Associated with lime nitrate and with it used to manufacture *salt petre*.

718. Magnesite. MAGNESIUM CARBONATE.

Occurs in soils and waters, but we have not seen crystallized specimens in Arkansas. Resembles forms of calcite and dolomite. Dissolves with effervescence in muriatic acid, but on adding sulphuric acid no calcium sulphate is thrown down. Associated with other magnesium rocks, and may be looked for in the magnesium limestones of Arkansas.

CALCIUM.

159. Fluorite. CALCIUM FLUORIDE.

Fluor spar. has not been reported but no doubt occurs. Should be looked for in the lead mines associated with calcite and Baryta. Crystals of a fine honey yellow color occur in the silurian rocks near St. Louis.

654. Gypsum. HYDROUS CALCIUM SULPHATE.

Composed of lime, sulphuric acid and water. Very soft. Turns white and crumbles when heated. There are several varieties of this mineral found in Arkansas.

Selenite includes the clear crystallized gypsum, which cleaves in plates of a pearly lustre. Occurs in Pike county, on Little River, in great quantity, also on Bacon and Brier creeks imbedded in clay. As small clear crystals in clay in Green county, as rhomb-shaped reddish crystals with beveled edges, at many places where decomposing shales containing pyrites are associated with limestone.

Radiated gypsum of great beauty has been observed in crevices of shales in Washington county.

Salin Spar. occurs in great abundance in Pike county.

Gypsiferous marls are found in Pike, Bradley, Washington and other counties.

The gypsum beds of Pike county are from 15 inches to 15 feet thick. Excellent material for the manufacture of plaster of Paris could be obtained, also it could be made use of for agricultural purposes. It is associated with limonite, limestone, pink and red clays, and salt. No *Anhydrite* has been reported, but probably occurs.

492. Apatite. CALCIUM PHOSPHATE.

Composed of lime. Phosphoric acid, and either chlorine or fluorine Occurs at Magnet Cove in hexagonal prisms of a greenish white color penetrating schorlamite and nephelite.

A constituent of the bones of animals. Found in shell marl, which owes its fertilizing properties to both the lime and phosphoric acid contained.

Widely disseminated in soils and gathered by plants for the use of animals.

Nitrocalcite occurs sparingly in caverns in north Arkansas.

715. Calcite. CALE SPAR. CALCIUM CARBONATE.

Composed of lime and carbonic acid. Takes on a great many forms and colors. Cleaves readily in the form of rhombohedrons. Yields lime before the blow pipe, and colors the flame red. Effervesces with acids. There are several varieties in Arkansas.

(a) *Iceland Spar.* showing double refraction well, occurs with galena in Washington, Carroll, Benton, and other counties.

(b) *Calcareous Tufa* occurs in large quantities deposited by the Hot Springs and Dripping Springs, in Garland county, and elsewhere.

Objects placed in the water at Hot Springs are soon coated. The tufa is often snow white, but usually brownish or reddish from iron and manganese impurities.

(c) *Stalactite and Stalagmite* are deposits of calcite from the top and on the bottom of caverns. Common in Arkansas. Sometimes white, but usually brown or gray. Often showing concentric layers. Beautiful stalactites with a mammillated exterior, and a core of clear and well crystallized calcite, occur in Carroll and Newton counties.

Massive calcite is called limestone. The following varieties occur.

(d) *Oolite.* Made up of small rounded grains resembling fish eggs. Common in Washington county and throughout the subcarboniferous formations. Makes the finest lime. Not so good for architectural purposes, as it weathers and crumbles readily on exposure. Takes a good polish, and beautiful for indoor work.

(e) Granular limestone embraces all forms made up of crystals, and called marbles. They result from ordinary limestones by the action of heated waters, and are found in places that have been subjected to igneous action. The color depends on impurities.

Encrinital marbles of a fine red and gray color occur in large deposits in Marion, Carroll, Newton and Searcy counties. The encrinite discs are usually white in a red matrix, giving a beautiful effect.

Black marbles of various shades occur in Independence, Van Buren, and Searcy counties. The black color is due to organic matter. The marbles of Arkansas perhaps would be more strictly classed as compact limestones.

(f) *Stink stone* is a variety which gives a fetid odor when hammered, due to organic matter. Common in north Arkansas.

(g) *Hydraulic limestone.* A clay limestone yielding a lime that sets under water. Occurs in north Arkansas at various places.

724. Aragonite.

Composition same as calcite, but crystallizes differently. Occurs at Magnet Cove, also in the gypsum beds of southwest Arkansas, and in Benton, Washington, and other counties of north Arkansas. Arkansas specimens are white and yellowish, and the structure fibrous. Some beautiful small stellate crystals are found in seams in shales in Washington county at Fayetteville.

716. Dolomite. MAGNESIUM LIMESTONE.

Composed of lime magnesia and carbonic acid.

(a) Massive dolomite is common in the northeastern part of the uplands. Some of it would make a good gray marble. Makes a stronger lime than calcite, which is called hydraulic cement.

(b) *Pearl Spar* is crystallized dolomite, and occurs in Arkansas as seams in dolomite, and as white, pink, and brown rhombohedral crystals associated with the zinc and lead ores.

BARIUM AND STRONTIUM.

630. Barite. HEAVY SPAR. BARIUM SULPHATE.

Occurs intimately associated with manganese ores in Independence county. So far as known does not occur as a gangue with the mineral deposits of north Arkansas.

631. Celestite. STRONTIUM SULPHATE.

Color, often blue, which gave the name.

Found at the gypsum beds in Pike county as bluish fibrous columnar crystals, in layers about two inches thick. This mineral is used to prepare strontium nitrate, a compound employed to give a red light in fireworks.

728. Strontianite. STRONTIUM CARBONATE.

Color, a light shade of green, also white, gray and yellowish brown. Dissolves in dilute acids with effervescence. Colors the flame bright red.

Used to prepare strontium nitrate, and in the purification of sugar. Found sparingly in Magnet Cove, also extensive deposits are said to occur in north Arkansas in Boone county.

SODIUM AND POTASSIUM.

138. Halite. COMMON SALT. SODIUM CHLORIDE.

The disturbance that elevated the uplands of Arkansas left the formations in a series of folds. The high portions have since been worn away by water action, forming troughs. These synclinals would no doubt yield salt water by deep boring. A well sunk at Fayetteville, on the premises of J. H. Van Hoose, yielded a strong brine. Salt licks are common in the uplands, while in Sevier county good salt springs occur in the cretaceous formations. Salt has been made quite extensively in Dallas and Hot Springs counties.

590. Nitre. SALTPETRE. POTASSIUM NITRATE.

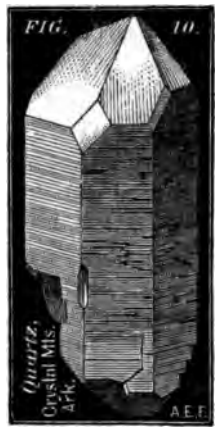
Occurs in caves in northern Arkansas, notably in Marion, Newton, Carroll, Independence, Washington, and Benton counties. These nitre earths have been lixivated, and yield from one to six per cent. of saltpetre.

175. Water. HYDROGEN OXIDE.

The water of the uplands of Arkansas is excellent. The tilted and folded sandstone and flint strata, with impervious shales below, give the most favorable conditions for springs. The strata have a general dip to the southwest in northwest Arkansas, and the most of the springs issue from the south sides of the hills. The springs are numerous and bold. The *Mammoth Spring* of Fulton county is remarkable for the flow, giving rise to Spring river. Sulphur, chalybeate, alum, copperas, salt, alkaline carbonate, magnesium, and hot springs occur in the State. Arkansas is noted for her watering places and medicinal springs. Hot Springs, Eureka, Siloam, Raven Den, and many others have claimed the attention of invalids.

SILICA AND SILICATES.

231. Quartz. OXIDE OF SILICON.



There are a great many varieties of quartz in Arkansas, varying greatly in color and lustre. The amount of silica in the State is remarkable. The forms may be divided into three groups :—

I. Vitreous Varieties.

Rock Crystal. Pure pellucid quartz. Found in the region about Hot Springs in long prisms on a sandstone base, or loose in clay or sand, doubly terminated. Often with liquid and clay inclusions. In Carroll and other counties in the flint hills as surface crystals without shafts, but large and finely terminated. The groups often have a cherty or chalcedonic core. Phantoms, clear quartz-crystals penetrated by other quartz-crystals, are common.

False Topaz. Light yellow clear crystals suitable for jewelry are found sparingly in the Hot Springs region.

Milky Quartz. A milk white massive variety common in various places in Arkansas in pebble beds, and in the metamorphic region.

Ferruginous Quartz. An opaque reddish variety colored with oxide of iron.

Smoky Quartz. Fine smoky crystals occur in Arkansas. The quartz becomes more smoky as you go west from Hot Springs.

Green Quartz crystals have been found in Saline county. Many of the forms of Arkansas quartz are cut for jewelry, though considerable placed on sale at Hot Springs is imported.

II. Chalcedonic Varieties.

Chalcedony of blue, white, yellow, brown and black colors is found lining cavities and crevices in the flint formations.

Cornelian is found about Hot Springs and other places in the flint hills.

Agates are not uncommon in cavities in cherty limestones of the millstone grit.

Novaculite. Occurs in large quantities near Hot Springs, and in Pulaski county. The finest material in the world for razor and bench hones is procured in Arkansas. Considerable is shipped to foreign countries in the rough. Small ornaments are also cut from the stone. It occurs in various colors.

Horn Stone Flint and Chert are common forms of quartz in the cherty limestones of Arkansas.

Buhr Stone. A cellular variety of quartz suitable for millstones. Occurs in Lawrence, Independence, Izard and Marion counties.

III. Jaspery Varieties.

Jaspery Iron Ore occurs in various places in the upland and in the lowland.

Silicified wood is very common in the low country. Petrified logs, stumps and branches are often found showing the grain perfectly.

Siliceous sinster is deposited with the tufa by the hot springs. There are found in the caves of northwest Arkansas beautiful white coralline and stalactitic forms of quartz.

Lydian stone occurs in Magnet Cove.

Sandstones of a white, gray, red, brown and yellow color, suitable for building purposes, are common in the millstone grit horizon.

Flag-stones of excellent quality also abound.

ANHYDROUS SILICATES.

238. Pyroxene. AUGITE.

Occurs at Fourche Cove in Basalt, as small and large jet black crystals; also as light colored crystals, associated with Labradorite.

Green coceolite is found in Magnet Cove.

239. Ægirite.

Is found at Magnet Cove as jet black prisms, sometimes nearly an inch thick and several inches long, penetrating microcline feldspar. The crystals are often well terminated. Also as acicular greenish black radiating crystals in microcline, and as green coatings.

Featherstonhaugh, in his report upon the elevated region between the Red and Missouri rivers, in speaking of Magnet Cove, says: "In various parts of the bottom I found large masses of decomposing feldspar, studded with black tourmalines, some of which were in long prisms, whilst others formed a stellated figure of beautiful acicular rays."

The above is a very lucid description of Ægerite as it occurs at Magnet Cove in microcline.

Dr. Owen does not mention tourmaline as having been observed by him. The writer has been several times in Magnet Cove and has found no tourmaline, and does not think it occurs in the State.

247. Hornblende.

Occurs at Fourche Cove as dark green crystals penetrating quartz, also in syenite. Found in the igneous rocks of Saline, Hot Springs, and Pike counties, and as *actinolite* in Magnet Cove.

269. Garnet var. Melanite.

Color, jet black. Found at Magnet Cove well crystallized in rhombohedrons. Associated with *schorlamite*, and when massive hard to tell from it by the eye. The writer has a very brilliant crystal from this locality showing several sets of planes.

276. Epidote.

Occurs sparingly at Magnet Cove well crystallized, also as green coatings on microcline and in quartz.

293. Muscovite. NACRITE.

Occurs in granite at Fourche and Magnet coves, also at Kellogg's Mine Pulaski county, and in various places in micaceous shales. The green and yellow micas mentioned by Dr. Owen from Magnet Cove were probably *protovermiculite*. Some of the black mica of Arkansas may be *Biotite*.

304. Nephelite var. Elæolite.

Occurs as glassy flesh and greenish colored masses, often penetrated by crystals of apatite. Associated with schorlamite, ozarkite, garnet, etc. Called sunstone by the people. Found also in nepelitic granite. Takes a good polish, and might be cut for jewelry.

311. Laboradorite. LIME SODA FELDSPAR.

Occurs in Fourche Cove associated with augite in a gray rock. This mineral when polished often shows a beautiful play of colors.

315. Albite. SODA FELDSPAR.

Occurs well crystallized in short tabular prisms and twins at Magnet Cove and in several localities in that region. Also at Fourche Cove. Colors, gray, white, and cream. Fine groups of crystals are placed on sale at Hot Springs.

316. Microcline.

Occurs in considerable quantity, massive and crystallized, at Magnet Cove. Color, light green to white. Often penetrated by *Ægirite*. From Dr. Owen's description of the locality it is evident he mistook it for *calcite*. Has the same composition as the next species, but, as the name indicates, the angles of the crystals are a little inclined.

316. Orhoclase. COMMON FELDSPAR.

Occurs in the granitic rocks at Fourche Cove and elsewhere in the State. The angles to the crystals are 90°. Arkansas feldspar is usually grayish, giving a light color to the granitic rocks. There is some red feldspar in Magnet Cove.

334. Schorlamite.

Occurs massive in Magnet Cove, associated with nephelite, ozarkite, garnet, and apatite. Hard to tell from garnet. Often penetrated by radiating crystals of apatite. Color, black and sometimes iridescent. Breaks with a bright conchoidal fracture. Takes a good polish, and has been tried as a gem. It yields a dead black stone, between the rutile and black onyx. It occurs in sufficient quantities pure enough for jewelry. Has been spoken of as a mourning gem. It is the only gem of *metallic lustre* over 7 in hardness.

HYDROUS SILICATES.

377. Thompsonite var. Ozarkite.

Occurs in Magnet Cove, associated with nephelite, schorlamite, ægirite, apatite, and garnet, as radiating white crystals, also massive. This species was named by Prof. C. U. Shepard after the Ozark mountains. It was discovered by Dr. W. B. Powell. Prof. S. first regarded it as a hydrous silicate of lime and Yttria with traces of Thorina, Prof. Whitney decided it was a hydrous silicate of alumina and lime.

398. Talc. SOAPSTONE. STEATITE.

Occurs in Magnet Cove associated with chlorite slate, chert, and iron pyrites, in a vein several yards wide. Found in shales in Conway county with other magnesium compounds. In various places along the granitic axis, where the slates are frequently talcose. A deposit of light and dark green streaked soapstone occurs in Saline county, and promises to be a good quality. Steatite is used for fire stones in furnaces, stoves, and fire places, also as a polishing material, for making porcelain, and as a lubricant. Tailors' chalk is soapstone. The white powder used in shoe and glove stores to aid in putting on new goods is powdered steatite. It can be sawn in slabs and turned in a lathe. Ink stands and images, and small ornaments are made of it.

401. Pyrophyllite.

Resembles talc in crystallization, cleavage, color, greasy feel, and hardness. Talc is a magnesium silicate. This mineral an aluminous bisilicate. Specimens are found in the vicinity of Little Rock. Pyrophyllite slate is used to make slate pencils, and often called pencil stone.

402. Sepiolite. MEERSCHAUM.

There is a massive cream colored clay mineral found in Arkansas and called *meerschaum* by the collectors. *Probably Kaolinite.* It was exhibited in cubical blocks at Louisville Exposition, and also at New Orleans. The writer has no specimens at hand to examine, and cannot definitely classify it. Also a powdered white clay mineral was exhibited in paper packets labelled *mineral soap.*

411. Serpentine.

Scarce in Arkansas. The writer found a small vein of what seemed to be serpentine in a quartz rock near Hot Springs. The specimens are in the cabinet of the State University.

419. Kaolinite.

Results from the decomposition of aluminous minerals, especially feldspars. It is found in considerable quantity and of excellent quality at Fourche Cove, also in Saline and Pike counties ; resulting from the decomposition of granitic rocks. Occurs in the form of potter's clay and fire clay in Saline, Washington, St. Francis, and Green counties, also many other places.

The porcelain clay of Pulaski, Saline, and Pike counties, compares favorably with the New Jersey beds. The beds are not worked, but the clay has been tested and makes excellent ware. Medalions and other articles manufactured from it were exhibited at New Orleans. The potter's clay of Miller, Saline, and Washington counties makes good stoneware, and has been worked extensively at Benton in Saline county, and Boonesboro in Washington county.

Clays suitable for brick abound in all parts of the State.

Protovermiculite.

Hexagonal in habit. The writer has a fine crystal over two inches across, perfect on all sides, showing the hexagonal habit. It is, however, probably monometric. Resembles mica. Cleaves in thin laminæ and slightly flexible but inelastic. Color, grayish green in the interior plates, and silvery white on the outside. Plentiful in Magnet Cove, flanking the deposit of magnetite on the east. Imperfect crystals occur nearly a foot across. Associated with schorlamite, nephelite, and garnet. The yellow and green micas mentioned by Dr. Owen were this species. It was first examined by Professor G. A. Kœnig of the University of Pennsylvania.

450. Ripidolite. CHLORITE IN PART.

Occurs in Magnet Cove as a green mineral with a mica like cleavage. Associated with talc, pyrites, and quartz, in a vein several yards wide. Chlorite rocks are found in Pike, Saline and Pulaski counties, probably resulting from the alteration of hornblende. The green color of chlorite rocks is due to the iron they contain.

460. Thuringite. HYDROUS SILICATE OF IRON.

A compact massive mineral made up of pearly scales of an olive-green

or pistachio-green color. The mineral is tough, breaks with a subchoncoidal fracture. The powdered mineral has a greasy feel. Occurs in Arkansas at Hot Springs.

IV. Hydrocarbon Compounds.

Marsh Gas. LIGHT CARBURETED HYDROGEN.

This compound, mixed with nitrogen and carbonic acid, occurs in marshes where vegetable matter is undergoing decomposition, whence its name.

It is found in the earth in pockets, also about oil wells and coal mines. The fire damp of the mines is marsh gas. It is used for lighting houses and also for heating purposes, and by incomplete combustion for making lampblack. When pure it burns with a blue flame, but is usually associated with other hydrocarbons, which burn with a yellow flame and give the luminating power. In boring for water upon the premises of J. H. Van Hoose, in Fayetteville, Arkansas, a gas cavity was penetrated at a depth of about thirty-five feet, which yielded a considerable quantity of gas. There was pressure enough to force it through a considerable column of water with a gurgling sound. The eight-inch tube of the well was rapidly filled, and the gas when ignited burned with a continuous flame several feet high. The water finally rose in the tube and cut off the supply. By pumping out the water the phenomenon was repeated.

No experiments have been made to determine either the illuminating power or the quantity of the gas. It merits a careful investigation as it might be used for heating and illuminating the town. The water of this well is so thoroughly charged with salt and other mineral ingredients as to be unsuitable for drinking or culinary purposes. The water might be made use of as a source of salt.

767. Petroleum.

Pockets containing a few ounces of "Rock Oil" have been found in a black limestone in northwest Arkansas. This limestone is the variety called stinkstone, and gives a fetid odor when struck with a hammer owing to the presence of organic matter. The gas cavity spoken of under marsh gas is a favorable indication of petroleum. Oil experts who have visited this region say it resembles the oil fields of Ohio. The black color of shale is due to organic matter, and water issuing from shale formations or about coal veins is frequently covered with an iridescent film of oil, which is no indication of a deposit of petroleum. Petroleum occurs in the rocks of all ages, usually in cavities in the earth, and is obtained by boring. It is supposed to have been formed from the decomposition of vegetable and animal matter, both with and without the agency of heat. Black shales and some forms of bituminous coal yield oil when heated. The lignite coals of south Arkansas were tested by Dr. Owen and yielded forty to forty-five gallons of crude oil to the ton.

As north Arkansas is a region more or less disturbed by igneous forces, the occurrence of petroleum is not improbable. The coal of the Arkansas River valley, is semi-anthracite.

Petroleum is a mixture of many hydrocarbons, and is quite variable in composition.

Naptha, benzine, paraffin, kerosine and asphaltum are some of the pro-

ducts of petroleum obtained by distillation of the crude rock oil. Material for making analine dyes is obtained from the waste products of kerosine manufacture.

799. Amber.

This is a compound resin found in the more recent geological formations and supposed to be of vegetable origin. Occurs loose in the soil, imbedded in clay, or associated with bituminous coal and lignite. It is esteemed for mouth pieces to pipes. Insects are often enclosed in it. There is considerable artificial amber in the markets, as it is easily imitated. Has been reported from Poinsett county in lignite, also from Ouachita county where "segregations are found in the lignite, approaching amber and retin-asphaltum; in fact, much of the coal has a retin-asphaltum aspect."

831. Mineral Coal.

Massive. Color, black or brown; opaque; brittle. Composed principally of carbon with some oxygen, hydrogen, moisture; also earthy ingredients, which constitute the ash.

It is customary in examining coal to determine the moisture, volatile gases and oils, fixed carbon and ash.

The value of coal for various purposes depends upon the amount of fixed carbon, the volatile ingredients, and the amount and kinds of earthy impurities.

For the manufacture of illuminating gas, the volatile ingredients are essential; while for smelting purposes those varieties containing the most carbon and the least volatile matter are esteemed. Coal containing volatile matter and earthy compounds, rendering it unfit for smelting purposes, can be utilized after coking. Generally the less earthy matter a coal contains the better it is adapted for all purposes.

Every gradation, from coal with five per cent. ash, to black shale with a trace of organic matter, may be found about coal mines. Coal is known to be of vegetable origin. Roots, stems and leaves are found in the shale and clay associated with coal, and often the vegetable form converted into coal is retained.

Microscopic examination of coal reveals a vegetable structure. Every gradation from growing vegetation, through peat, brown coal, lignite, cannel coal, bituminous coal, antharacite to graphite, can be found.

By hydraulic pressure peat in converted into a substance having many of the properties of coal.

It is supposed to have been formed in extensive swamps at different times in geological history. The rank vegetation of those periods became submerged by the sinking of the earth's crust, and buried beneath heavy deposits of debris, and being subjected to heavy pressure away from the air, was converted into various forms of hydrocarbons.

There are a great many varieties of coal depending upon the degree of bituminization, the amount of fixed carbon and volatile matter, and the way they burn. The following varieties are found in Arkansas:

Peat. Considerable peat is found about springs in north Arkansas, also in the swamps of the low country. Results from partial decomposition of swamp plants. Quaking bogs are common, and some of them have yielded remains of ancient horses and elephants.

Brown coal occurs extensively in the recent formations of the south and east parts of the State. The beds are from a few inches to over four feet thick.

They have been examined in Greene, Ouachita and other countries and found to be of fair quality; yielding a high per cent. of volatile matter. Whether they are adapted for manufacturing illuminating gas and coke, is an open question. The most of the coal is structureless and crumbles on exposure, but some shows the woody structure and is then called *lignite*.

Bituminous and *semi-anthracite* coal occur in the true coal measures of the uplands of Arkansas. The amount of volatile matter decreases as you approach the granitic axis, and bordering the seat of greatest disturbance graphitoidal carbon is found.

The coal of northwest Arkansas is quite free from sulphur, and is preferred for blacksmithing purposes to the coal imported from Kansas. The semi-anthracite of the Arkansas valley contains over eighty per cent. of fixed carbon.

The coal field of north Arkansas belongs to the western interior coal area, which covers the greater part of Missouri, and extends into Iowa, Kansas, Nebraska, Indian Territory, Arkansas, and Texas. This vast field covers 78,000 square miles, of which about 10,000 are in Arkansas, and 12,000 in the Indian Territory.

There are four great coal horizons recognized in the coal measures, viz: the subconglomerate, lower, middle, and upper.

The coal field of Arkansas belongs to the lowest, the *subconglomerate*. The veins occur in the shales of the millstone grit, less than 100 feet above the Archimedes limestone. There is only one vein in the northern limit, which is from eight inches to eighteen inches thick. In the Arkansas River valley these veins often have an aggregate thickness of over six feet. The veins lie high in the hills in the Boston Mountains, but the southward dip brings them in the Arkansas River valley beneath the drainage of the country.

The veins in north Arkansas are worked in a limited way by scalping and drifting, but shaft mining is done at Coal Hill, Spadra, and other points, and there is at present considerable coal exported to New Orleans down the Arkansas Valley route.

It would be useless to search for coal in Arkansas below the limestones of the subcarboniferous age, as experience has demonstrated that they are at the bottom of the workable coal measures.

Beautifully preserved plants occur in the shales above the coal vein of northwest Arkansas, and limited research in Washington county alone, yielded the writer over 100 species new to the State, and fifteen new to science. Fossil plants are of great importance to the geologist in determining the relative age of coal strata and the probable existence of other veins.

The coal fields of the Indian Territory are claiming considerable attention, and are a source of supply to the railroads of the Gould combination, as well as most of the roads of the Southwest. There is considerable demand for this coal by gas companies, and much is shipped to the cities of Kansas, Nebraska, Missouri, and Texas. The daily yield of all the mines is over 3000 tons.

Coke is made from the refuse, and being free from sulphur and phosphorus has gained considerable reputation among foundry men and blacksmiths.

The coal of Arkansas is similar to that of the Territory, and could be used for locomotives, manufacture of gas, and by coking for manufacturing and smelting purposes.

ROCKS.

The term rock is usually applied to a mass of inorganic matter made of a single mineral or of an indefinite mixture of several minerals. Being usually indefinite mixtures of chemical compounds, rocks are variable in composition; shade into each other, and are hard to classify. Limestone is almost entirely made up of the species calcite or dolomite, sandstone of quartz; but most rocks are composed of several mineral species.

Silica, silicates and calcium minerals are the chief constitutens of rocks. Quartz in the form of sandstone and quartzite makes up about one-third the earth's crust. The silicates, as feldspars, micas, hornblende, epidote, shales, etc., occur in extensive deposits.

Calcareous rocks, as limestone, dolomite, gypsum, and marble, are found in formations of great thickness over wide areas.

Rocks may be classified as follows:

Rocks	Fragmental.	
	Crystalline, . .	Igneous or eruptive,
		Metamorphic,
		By Chemical deposition.
	Calcareous.	
	Carbonaceous.	

Fragmental rocks are nothing more than solidified sand, pebble, mud, or clay beds.

Sandstone and shales are the common forms. The material was derived from other rocks by the action of the atmosphere and water; deposited in the lowgrounds in strata, and afterwards cemented by calcareous matter, the oxide of iron or clay.

Crystalline rocks, in most cases, have originated from fragmental by the action of heat, heated waters or chemical action.

Igneous rocks or *eruptive* are those that have become crystalline by cooling after fusion.

Metamorphic rocks have been changed from the fragmental to the crystalline form without fusion, by percolating hot waters. The same kinds of rocks often result from metamorphic and igneous forces. All rocks which are made from material forced in the molten form through crevices of the earth's crust would be igneous or eruptive.

Crystalline Rocks by *chemical deposition*, from waters holding calcareous and silicious material in solution, are common. Stalactites, stalagmites, tufa, and the silica deposited by geysers are examples.

Calcareous rocks are represented by limestone which is of animal origin, being made up of the shells, and calcareous remains of corals and other sea animals.

Carbonaceous rocks are represented by the coal veins of the earth's crust, which are of vegetable origin.

The following rocks are found in Arkansas.

FRAGMENTAL ROCKS NOT CALCAREOUS.

Conglomerate a rock made up of angular or rounded pebbles of *any kind*. Calcareous conglomerates are common in the flint hills of Arkansas. Silicious conglomerates and sometimes rocks made of sand, lime, and shale peb-

bles, together with fragments of fossils, occur in the millstone grit formations. Conglomerates are common in south Arkansas, though not so well cemented.

Grit, a coarse sandstone composed of sand, or sand and pebbles, is very common in the *millstone grit* formations. They derive their name from this fact.

Sandstone has been considered partially under *quartz*. Ferruginious, argillaceous, laminated, gritty, fossiliferous, and micaceous sandstones occur in Arkansas. The names indicate their nature and need no explanation. Some of the Arkansas sandstone would make good grindstones.

Sand Rock.

This name applies to a rock made of sand but not quartz. The oolitic limestone of Arkansas would be a calcareous sand rock.

Shale.

A soft, fragile, argillaceous rock, which cleaves in irregular masses, usually horizontal with the bed. Black, purplish and red shales are common in Arkansas. They are commonly called slate, but the next is true slate.

Argillyte. Roofing Slate.

Differs from shale by splitting in even thin slabs. Roofing slate is a good example. Found in metamorphic regions and formed from shales by the action of igneous forces. Roofing slate occurs in Sevier county. Talcose and micaceous slates occur along the granitic axis.

Sand.

Is finely divided rock material of any form, but quartz sand is the kind used for plastering, and is common in Arkansas from the weathering of sandstone.

Alluvium is the name given to the deposits of rivers and lakes, especially in flood time, and makes up the soil of the river valleys everywhere.

Tripolyte.

Deposits of a chalky material occur in south Arkansas which resemble diatomaceous earth. They have not been examined microscopically for the shells of diatoms. Tripolyte consists of the minute silicious shells of a low form of plant called diatoms.

CALCAREOUS ROCKS.

Under this head are included all the forms of limestone, hydraulic limestone, dolomite, marl, calcareous tufa, stalagmite, and marbles. They all occur in Arkansas and are considered under calcite.

SILICIOUS CRYSTALLINE ROCKS.

Quartzyte. GRANULAR QUARTZ.

Is a name applied to silicious sandstones that have lost more or less the fragmental structure by the action of igneous forces, becoming very fine in texture.

There are a great many varieties depending upon texture and impurities.

Massive Quartz of a white color is common along the granitic axis in Arkansas in veins penetrating the slates, or in masses. The most of the sandstone of central Arkansas, is more or less converted into quartzyte.

Novaculite or Honestone, is a variety of quartzyte which occurs at Hot

Springs and various places, and is supposed to have resulted from the action of hot waters upon ordinary sandstone. It occurs in various grades of fineness and is used for benchstones and hones.

Chert.

An impure flint, found in immense quantities in the cherty limestones of north Arkansas. It varies in color, but the chert of Arkansas is mostly light colored, giving a gray appearance to the soils and hills. Broken into angular fragments. Sometimes a conglomerate.

Buhr Stone, a cellular silicious rock suitable for millstones. Occurs in in Independence, Izard and Lawrence counties; also in southwest Arkansas.

MISCELLANEOUS CRYSTALLINE ROCKS.

Granite.

Composed of quartz, feldspar and mica. These ingredients differ in relative quantity, color and size of the crystals, giving a great number of varieties. Typical granite occurs in Fourche Cove, Saline county, and Magnet Cove. The following varieties are also found in Arkansas.

Hornblendic Granite, having a small quantity of hornblende with the quartz, feldspar and mica, occurs in Fourche Cove. Might be called *granitic-syenyte*.

Porphyritic Granite.

Porphyry is any fine-grained feldspathic rock containing large crystals of feldspar. Occurs in Saline county, Fourche Cove, Magnet Cove and Pike county.

Graphic Granite.

A granite containing angular crystals of feldspar which resemble Hebrew characters. Found in Saline county.

Feldspathic Granite contains a preponderance of feldspar and occurs at Fourche Cove, Pulaski county. This has been used to make an inferior millstone.

Trachyte.

A rock consisting mainly of feldspar, and containing glassy crystals. Breaks with a rough fracture. Gray Trachyte occurs in Fourche Cove and from the weathering of it kaolin beds have been formed.

Green Trachyte is found in Pike county.

Syenyte.

Composed of quartz, feldspar and hornblende. Occurs at Magnet Cove. Color, grayish.

Hornblende Rock.

Massive Hornblende is found at Magnet Cove, also porphyritic hornblende, and hornblendic slate. There is at Fourche Cove a grayistic rock composed of Augite and Labrador feldspar.

Nephelitic Granite.

There is a granite like rock in Magnet Cove of a reddish-gray color containing nephelite.

Green Stones are associated with the other crystalline rocks, especially in Pike county, where they are porphyritic.

Doleryte. TRAP. BASALT.

Basalt occur at Fourche Cove as compact close-grained augitic rock, porphyritic basalt and ferruginous trap.

Chlorite and Talcose Slates. Occur along the granitic axis.

Ferruginous Amygdaloidal rocks are found in Fourche.Cove

Steatyte occurs in limited quantities in Saline county.

Schorlamitic *rock* and massive *magnetite* occur in Magnet Cove.

Probably a good many other varieties of crystalline rocks will be found where the metamorpic region of Arkansas is studied in detail.

DURABILITY OF ROCKS.

The durability of a rock depends upon compactness, finenesss of grain, uniformity of structure, and freedom from substances acted upon by the gases and moisture of the atmosphere.

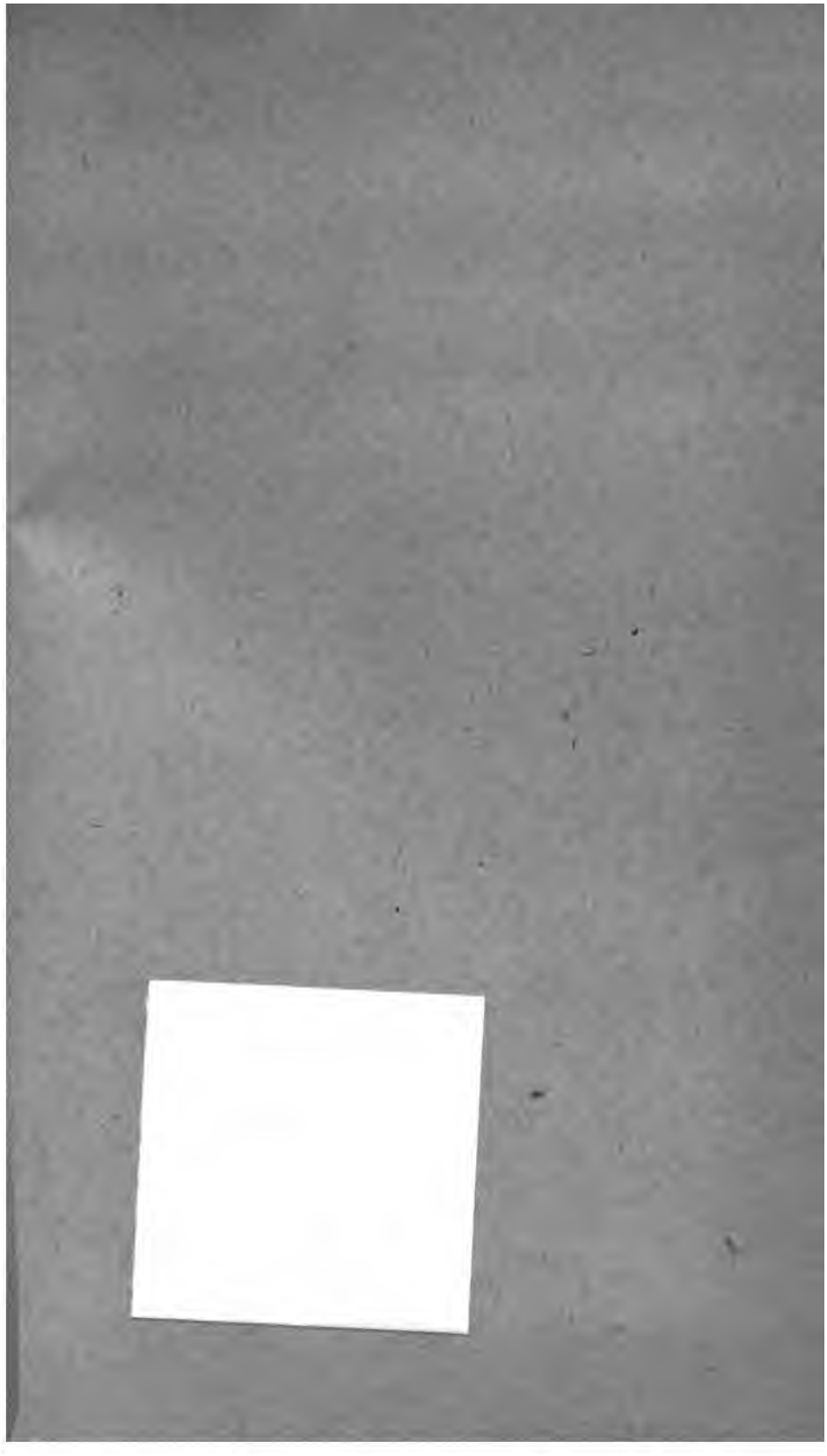
A porous rock that absorbs and holds much moisture would not be suitable for a cold climate, as it would be cracked by freezing. A rock lacking uniformity of texture would be cracked by unequal expansion during a change of temperature. Some rocks contain chemical substances, as pyrites, etc., which are chemically acted upon by the atmosphere causing disintegration. Rocks for building purposes should be chemically satisfied. An examination of a rock in the bed decides whether it would stand the action of the air. The rainfall and average annual temperature have much to do with the durability of rocks. Polished rocks are more durable than those with a rough surface. Granites, sandstones, and roofing slates are among the most durable rocks, and withstand the action of gases and moisture better than limestone. Sandstones cemented with peroxide of iron are much more durable than those with a clay or calcareous cement. A close-grained granite with much quartz and a little feldspar is the best. For durability a rock should be placed in the wall as it was found in the bed.

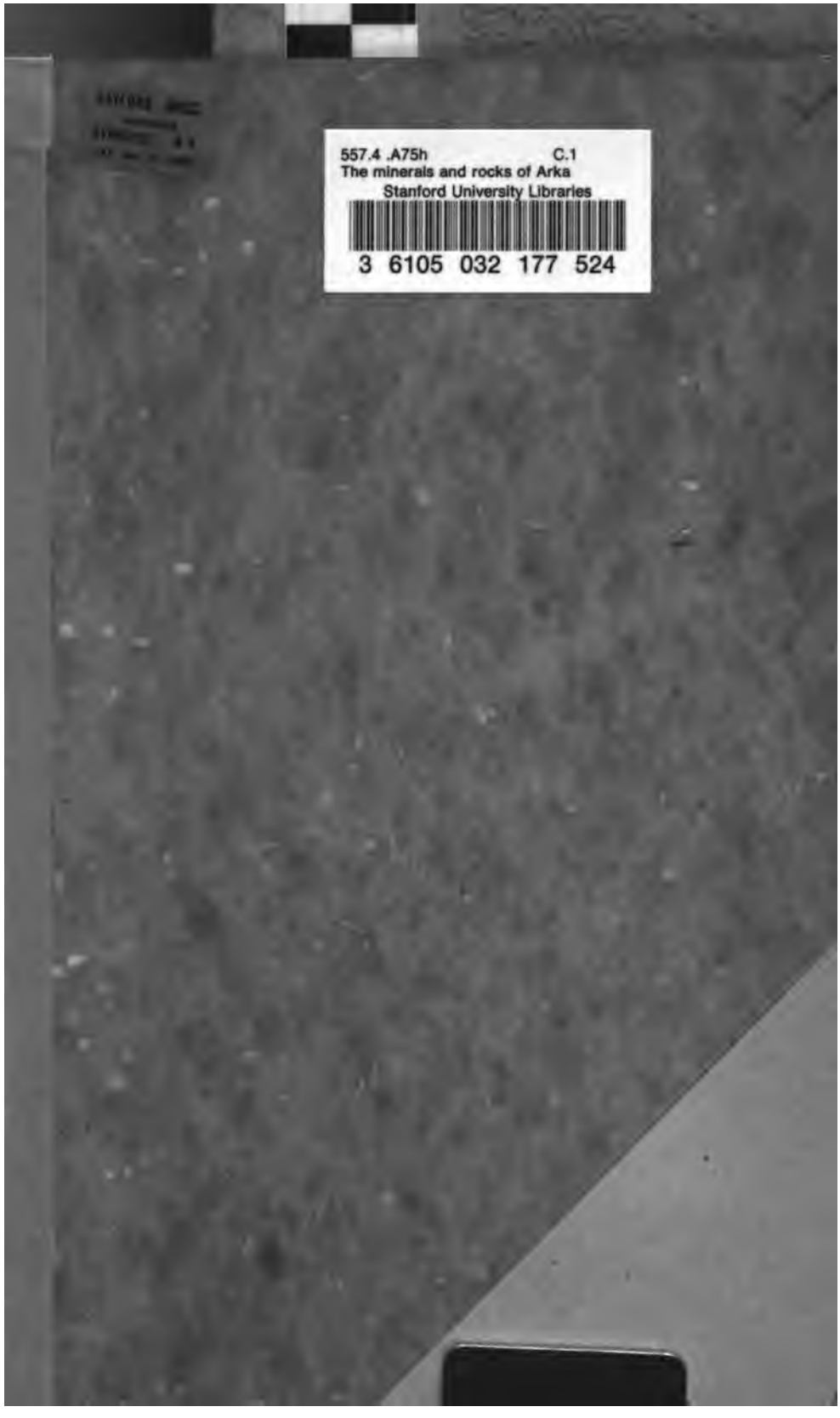
The sandstones of Arkansas are cemented mostly by peroxide of iron, the most durable cement. The limestones are largely fine grained, compact, and even in texture.

The syenytic-granites of central Arkansas are fine grained; even in texture, contain but little mica and hornblende, and rather too much feldspar. They however, make a good stone for bridge work and buildings. Vast quantities of good granite occur in Fourche Cove, Saline county, and at Magnet Cove.

CONCLUSION.

The short description in the above pages of the minerals, rocks, and soils of Arkansas, will convince the casual reader that there are great resources in and beneath the soil of the State, which only need wealth and enterprise to develope. By the opening of mines the agricultural capabilities of the State will be stimulated, commerce and manufactures encouraged, immigration take place, and all things combine to increase the prosperity of the State.

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